HYCOM and GODAE in Relation to Navy Ocean Prediction

An Overview Presented by

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NRL Effort Related to HYCOM

Modeling

Harley Hurlburt
Birol Kara
Joe Metzger
Jay Shriver
Alan Wallcraft
Xiabiao Xu (Postdoc at USM)

Data Assimilation

Jim Cummings
Ole Martin Smedstad (PSI)

Regional Modeling and HYCOM Boundary Conditions for Regional/Coastal Models, Including COAMPS

	Nested Model		***Nested Model***
Pat Hogan	*HYCOM*	John Kindle	*NCOM or HYCOM*
Luis Zamudio (FSU)	*HYCOM*	Sergio Derada	*NCOM or HYCOM*
Prasad Thoppil (Postdoc at USM)	*HYCOM*	Stephanie Anderson	*NCOM or HYCOM*
Kyung-Hoon Hyun (Postdoc at USM)	-	Julie Pullen (NRLMRY)	*COAMPS*
Cheryl Ann Blain	*finite element*	Paul May (CSC in MRY)	*COAMPS*

Collaborative Effort on HYCOM for Ocean Prediction

Coordinated 6.1-6.4 effort with university, NOAA and international collaboration

- **6.1 Global Remote Littoral Forcing via Deep Water Pathways**
- **6.1 Indonesian Throughflow**
- **6.1 ONR Philippine Straits DRI**
- **Navy/NOAA/Univ./Internat. HYCOM NOPP GODAE**
  - **development of a next generation global ocean prediction system, including boundary conditions for multiple coastal models and COAMPS**
- **Participating in multinational Global Ocean Data Assimilation Experiment (GODAE)**
- **6.4 Large-Scale Prediction and Ocean Data Assimilation**
  - **For transition to NAVOCEANO**
- **6.1 SEED ARI, 6.2 CO-NESTS and NOPP CODAE**
  - **boundary conditions for a variety of coastal models**
- **DoD HPC challenge and non-challenge computer time**
  - **Largest Navy user of DoD HPC**

U.S. Navy Present and Planned Global Ocean Prediction Systems

Global Product	Mid-Lat Resolution	Vert. Coord.	Inputs	Run By	Actual or Target Date
1/16° NLOM	7 km	Layered	SSH, SST, hydro, FNMOC NOGAPS Atmospheric Forcing	NAVO	OP 9/01-3/06
1/8° NCOM [1]	15 km	σ/z		NAVO	OP 2/06
1/32° NLOM [2]	3.5 km	Layered		NAVO	OP 3/06
1/12° HYCOM [3,5]	7 km	ρ/σ/z		NAVO	2007
1/25° HYCOM	3.5 km	ρ/σ/z		NAVO	2011
Near Real-time demonstration					
1/12° Atl. HYCOM [4,5]	7 km	ρ/σ/z		NRL	2002

OP = operational

[1] High vertical resolution for mixed layer prediction. Assimilates SSH from NLOM via T and S synthetic profiles. Web page http://www.ocean.nrlssc.navy.mil/global_ncom

[2] Web page http://www.ocean.nrlssc.navy.mil/global_nlom

[3] Running in real time at NAVO.

[4] Under the National Ocean Partnership Program (NOPP), 1/12° Atlantic HYCOM demo is running in near real-time. Includes the Mediterranean Sea.

[5] Results at http://www.hycom.org (100Tb LAS server at FSU)

Nesting Strategy for Ocean Prediction

Global	→	Regional	→	Littoral	→	Nearshore

Near-term: present-FY04 in R&D, FY04-FY08 operational, including transition

1/8° NCOM	→	NCOM or SWAFS	→	NCOM or SWAFS	→	ADCIRC
15-16 km mid-lat resolution	→	4 - 8 km, larger regions	→	< 1 to 2 km res	→	< 2 km resolution finite element

Mid-term: FY04 - FY08 in R&D, FY07 – FY12 operational, including transition

1/12° HYCOM	→	HYCOM	→	*NCOM or HYCOM	→	ADCIRC
7 km mid-lat resolution	→	2 - 4 km, smaller regions	→	.5-1.5 km res	→	< 1.5 km res

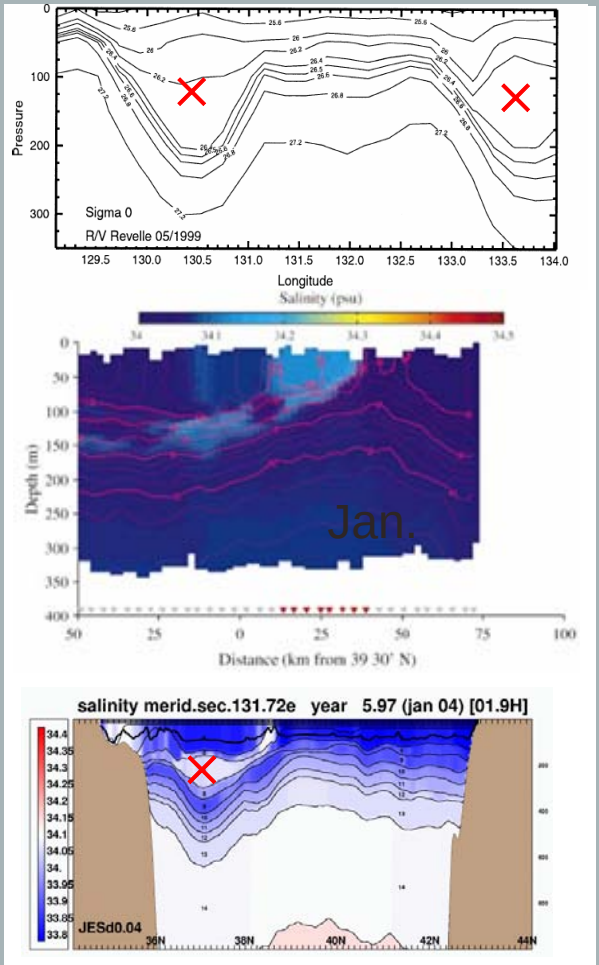
Long-term: FY07-FY12 in R&D, FY11 and beyond operational, including transition

+1/25° HYCOM	→	Regional generally not needed	→	*NCOM or HYCOM	→	ADCIRC
3 - 4 km mid-lat resolution	→	Not used	→	≤ 1km res	→	≤ 1 km res

*Hogan and Kindle CO-NESTS project will provide research results needed to make the appropriate choice. An alternative model such as ROMS may also be considered.

+1/25° HYCOM gives useful littoral resolution globally

HYCOM Helps Explain the Formation of Intra-Thermocline Eddies (ITEs) in the Japan/East Sea



Observed ITE

May 1999 Observed density cross-section from Gordon et al. (2002, JPO) along 37.75°N

Observed frontal subduction

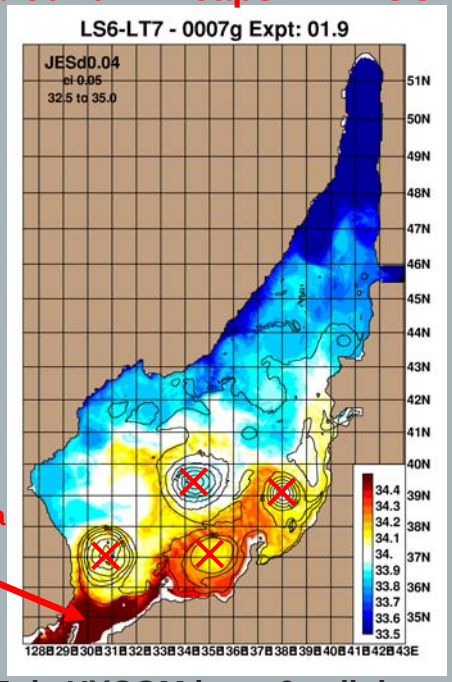
Jan 2000 Observed cross-section of temperature (contours) and salinity (color) along 134.4°E. From Gordon et al., 2002, JPO

Simulated frontal subduction into an ITE

January HYCOM cross-section along 131.7°E. Salinity on model layers, isopycnal with z-levels near the surface

ITEs marked by ×

Plumes of salinity wrap around ITE caps in HYCOM



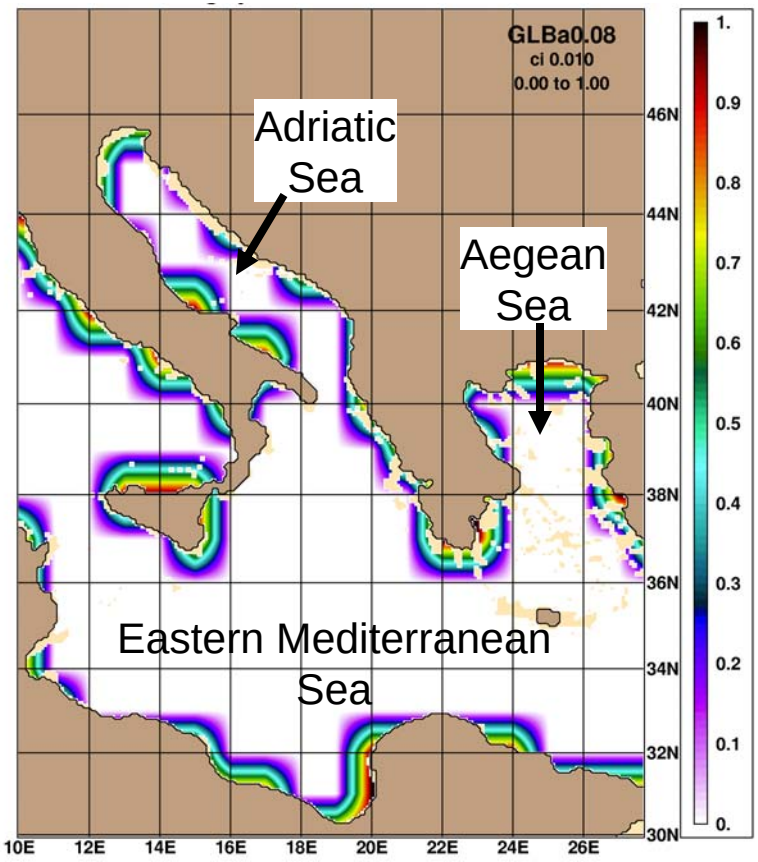
July HYCOM layer 6 salinity (color) superimposed on layer 7 thickness contours

From Hogan and Hurlburt (2006, Oceanography)
ONR JES DRI follow-up

Ongoing Work on Atmospheric Forcing

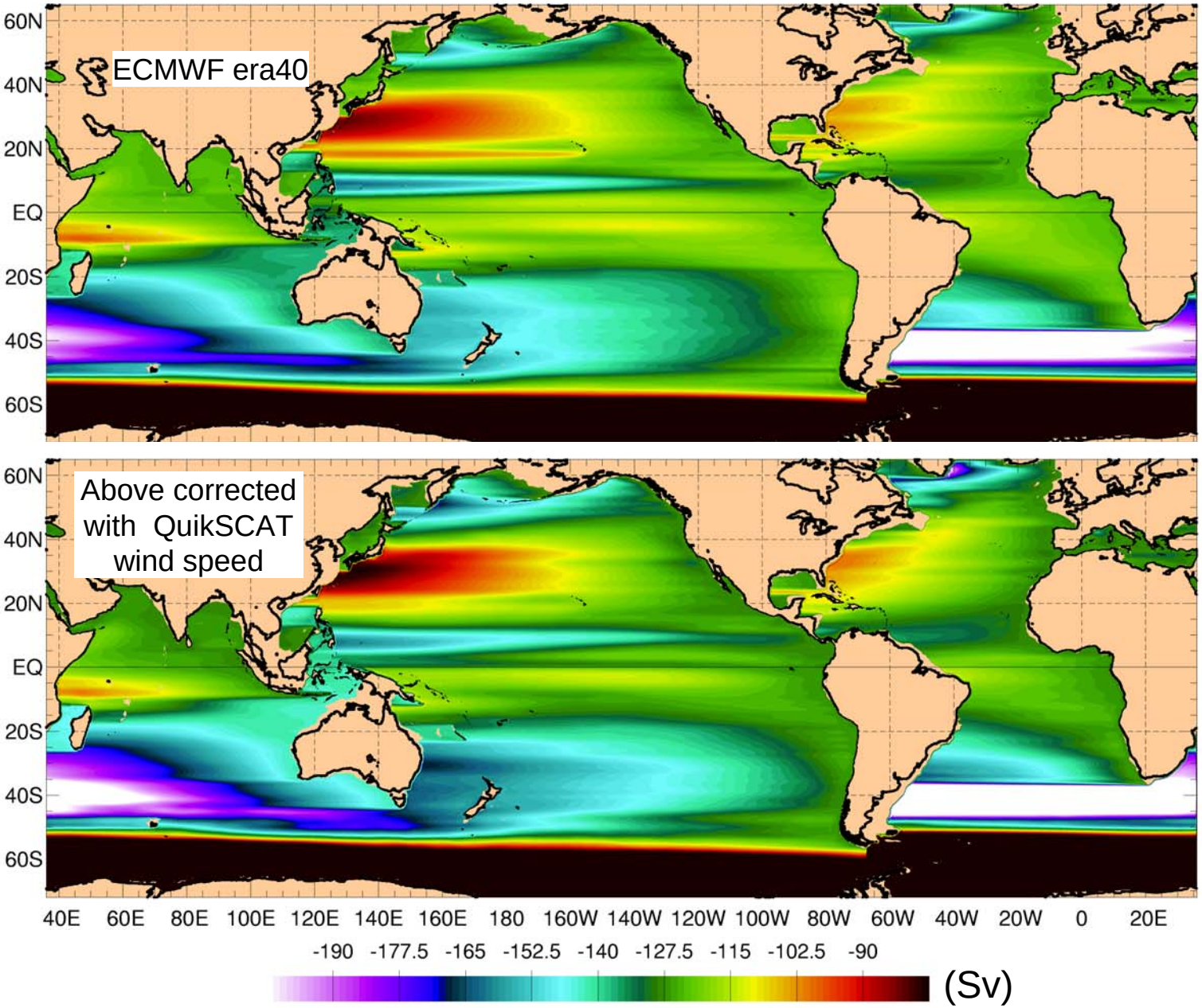
- New schemes for shortwave radiation penetration with turbidity
  - Kara et al. (2005, JPO), Lee et al. (2005, JGR-O)
- Creeping Sea Fill (Kara et al., 2007, JPO)
  - For removal of land contamination of sea grid points from any scalar atmospheric forcing field
  - Or filling data gaps, e.g. near land
- Satellite-based corrections to short and longwave radiation, wind speed, and precipitation monthly mean climatologies
  - Approach can be used for any sub-daily inter-annual or real-time atmospheric forcing product of choice, e.g. NOGAPS
  - Short and long wave radiation corrected using ISCCP climatology
  - Wind speed corrected using scatterometer or SSM/I climatology
    - Product wind direction retained
  - Precipitation is corrected using GPCP climatology

NOGAPS Land/Sea Mask over the Eastern Mediterranean Sea Region

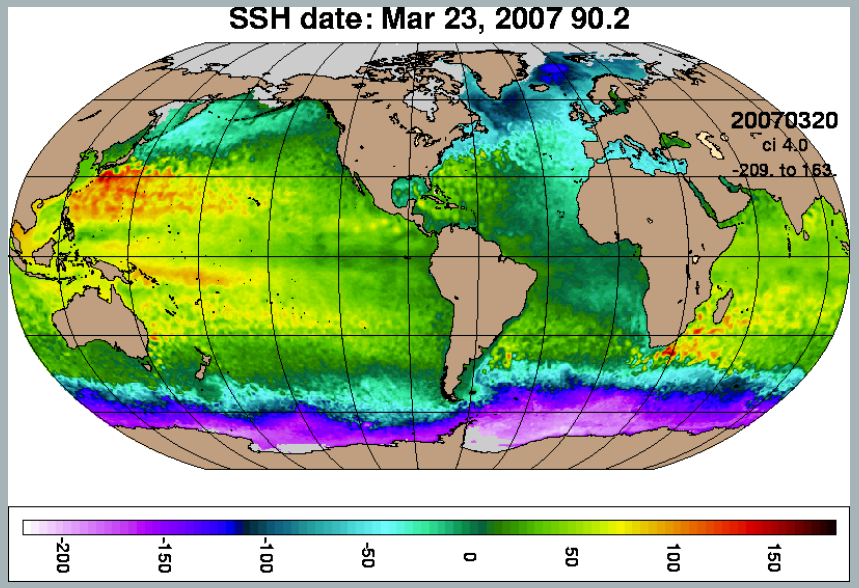


Color bar is fractional land contamination after interpolation to the .08° global HYCOM grid

1/16° Global Linear Sverdrup Flow Circulation

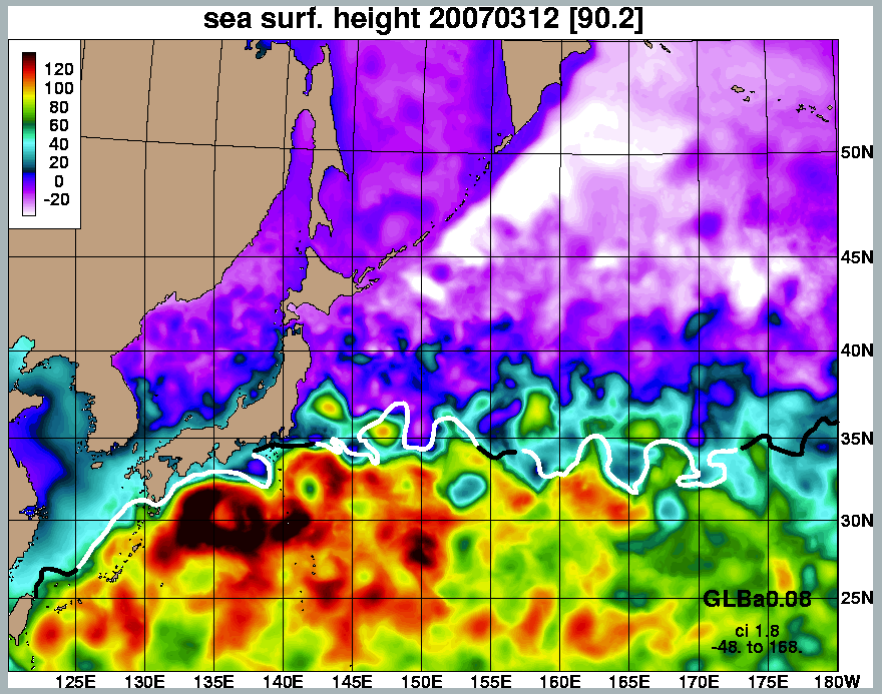


Results from Real-Time .08° Global HYCOM with NCODA Data Assimilation



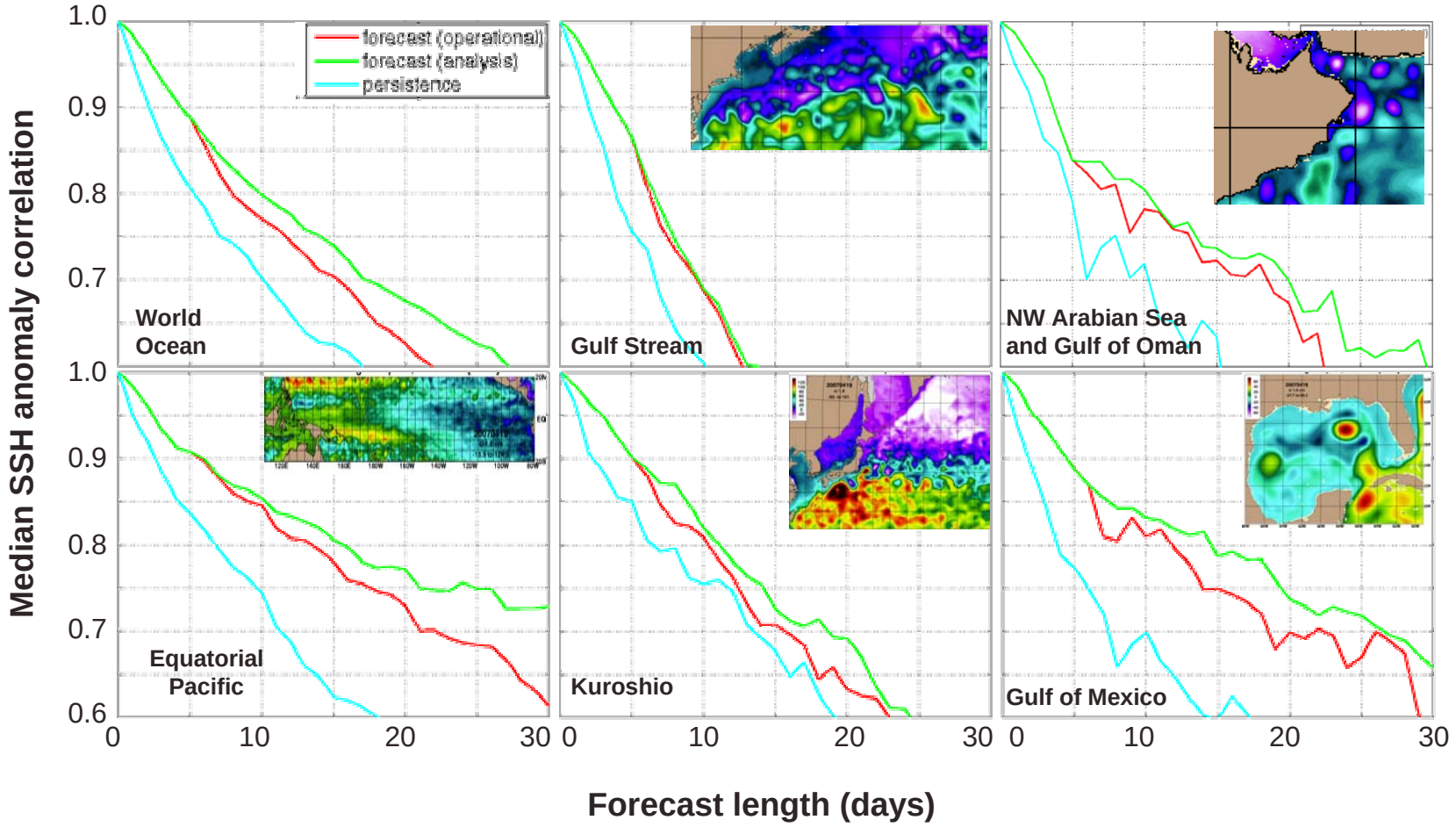
Sea Surface Height (SSH) in cm

Global SSH on 23 Mar 2007
Gray areas are ice covered



NW Pacific SSH zoom on 12 Mar 2006
NAVOCEANO operational analysis of the Kuroshio front based on satellite AVHRR imagery is overlaid
— black segments are based on imagery > 4 days old

Forecast Verification Statistics from .08° Global HYCOM



4 Forecasts included in statistics